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Tracking Servobridge Detector

Final Report

Contract DAAB05-73-C-0609

Industrial Management Division

Procurement and Production Directorate

U. S. Army Electronics Command

VOLUME II



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This report is in three volumes - Volume I describes technically the Tracking Servobridge Detector in final configuration after passing all of the requirements of MIL-D-55361(EL). Volume II describes the Production Engineering Measures required for the pilot production of these units. Volume II includes flow charts, equipment and tooling lists, sample operation sheets, other data required for production and review of the program. Volume III contains all of the Operation Sheets required to fabricate (Gen-Rad manufactured) components and to assemble and test subassemblies and tracking Servobridge Detectors.			

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- * ELECTRIC BRIDGES
- * DEMODULATORS
- * MEASURING INSTRUMENTS

- PRODUCTION ENGINEERING
- SERVOMECHANISMS
- QUARTZ RESONATORS
- SUPERHETERODYNE RECEIVERS
- PLANNING
- TOOLS
- FABRICATION

24 DESCRIPTOR CLASSIFICATION	U CRD	C CFRD	S SRD	R SFRD
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25 IDENTIFIERS AND/OR OPEN-ENDED TERMS

- SYNCHRONOUS DETECTORS
- GERMABIDGE DETECTORS

PRODUCTION ENGINEERING
 SERVOMECHANISMS
 QUARTZ RESONATORS
 SUPERHETERODYNE RECEIVERS
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 TOOLS
 FABRICATION

24 DESCRIPTOR CLASSIFICATION	U CRD	C CFRD	S SRD	R SFRD
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SYNCHRONOUS DETECTORS
 SERVOBRIDGE DETECTORS

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Tracking Servobridge Detector

Final Report

VOLUME II

The object of this study is to perform the design, development engineering, fabrication of special tooling and test fixtures, obtain first article approval and establish a pilot line and pilot run for tracking servobridge detectors.

DAAB05-73-C-0609

Prepared By: W. M. Twadell

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APPENDIXES

I.

INTRODUCTION

The Electronics Industry has long recognized the desirability of improved techniques to measure the equivalent electrical parameters and characteristic qualities of quartz crystal resonators. The U. S. Army Electronics Command has fostered the development of an Universal Precise Crystal Measuring System to measure these parameters and characteristics.

An essential element of this system is the Tracking Servobridge Detector (TSBD) on which the development was completed and a total of 14 units prototyped and fabricated. Other key items in the System on this contract which require further development are a Microcircuit Bridge with Autobalancing Unit, an Offset Local Oscillator, ovens and a Crystal Handling Subsystem. Presently available off-the-shelf items, such as a frequency synthesizer, oscilloscope, plotter, counter, would also be needed for a fully functioning system.

Completion of the fully operating system will permit the test and evaluation of quartz crystal resonators more accurately than heretofore possible. This system will be designed also to perform these measurements more rapidly than previously possible and, thus provide a cost advantage over current techniques.

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II.

PURPOSE

This report covers the development of the Tracking Servobridge Detector from a breadboard model through First Article Testing and the pilot production fabrication of ten units.

Volume I of this report covers the design and theory of operations of the Tracking Servobridge Detector (TSBD). Although a breadboard model of the TSBD existed, additional design work was required in order to achieve the required performance. During this design phase, the desirability of changes in the specification were recognized. A revised specification for the production units was, therefore, prepared and submitted for approval.

Before assembly of pilot production units was initiated, two first articles were fabricated and tested for compliance to the amended specification requirements. Design or component changes required to conform to the specification were incorporated into the pilot production models. A report of the First Article testing has been previously submitted.

This Volume II is concerned with the manufacture and test of the ten Pilot Production models and the procedures, plans and instructions, necessary to accomplish the manufacture and test of these units. In addition, there is included a brief description of the production problems encountered and a summary of the performance of the pilot production units.

Volume III contains the Operation Sheets developed for use in the fabrication and assembly of the parts, subassemblies and assemblies manufactured by GenRad.

III.

PRODUCT BREAKDOWN STRUCTURE

As the product was being designed, there developed a logical set of subassemblies, such as power amplifier, IF amplifier, power supply, etc. Basic design consideration such as shielding, power dissipation and input/output isolation dictated significant portions of the mechanical design. Nevertheless, a reasonable number of printed circuit assemblies of reasonable complexity and difficulty resulted. The complete assembly with subassemblies is shown in Figure 1 (2995-9503-FLO). An indentured parts list is prepared for each assembly (and subassembly). The parts list for the final assembly and one subassembly (R.F. module and main power supply printed circuit board) are enclosed in Appendix A as examples. The Parts List provides the description, circuit symbol number, quantity required and the 8 digit GenRad part (stock) number. There exists a drawing or specification sheet for each part number.

These parts lists can be summarized to develop a complete, consolidated parts list. Whereas the vast majority of components used were readily available in the required quantities as standard stock items, it was not necessary to develop a consolidated list. In production, the parts lists, however, would be key punched and entered into the standard GenRad computerized production control system. The parts requirements were reviewed for make-or-buy decisions where appropriate. For parts being purchased, a Vendor Source List was developed. A copy of the list is enclosed in Appendix B. Procurement of components, if necessary, would be made utilizing the 8 digit specification sheet.

For fabricated parts, suitable detailed drawings were prepared. For printed circuit boards, dimensionally stable artwork was drawn and photographed. For sheet metal and other machined parts, detailed drawings including finishing instructions were prepared. In accordance with our standard practice, operation sheets were prepared for each fabricated part, subassembly and assembly. Sample copies of operation sheets are included in Appendix C. A complete set of operation sheets will be found in Volume III of this report. Drawings and Parts Lists have been provided separately as required by Contract.

IV. DEVELOPMENT OF PROCESS FLOW CHARTS AND OPERATION SHEETS

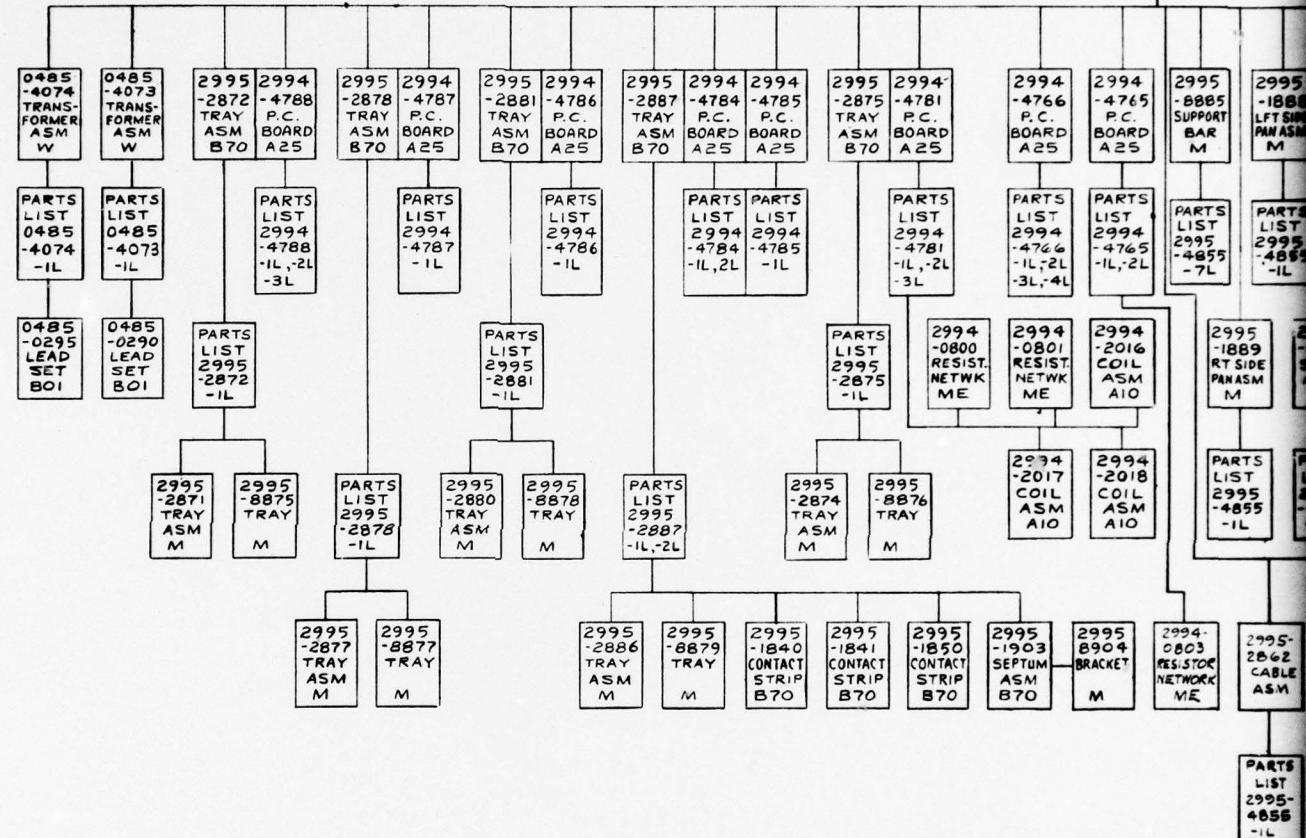
To assist in understanding these operation sheets, we have prepared a flow diagram for the three most frequent and typical operations. Figure 2 describes the flow for printed circuit boards. Figure 3 is for transformers and Figure 4 is for coax cable assemblies. The diagram specifies the assemblies to which the diagram applies and provides a key for the work stations involved. A complete description of the work stations is enclosed as Appendix D. The operations sheets and indentured parts list are suitable for keypunching and incorporation in our computerized production and material control system used for production quantities of instruments. The same system would be utilized for the production of follow-on quantities of Tracking Servobridge Detectors.

The Operation Sheets were prepared by the Production Engineer. Figure 5 is a typical Operation Sheet. The order quantity is specified in the upper left hand corner. It was determined that for a production of 25 units per month that a lot size of 25 subassemblies was optimum. The material required for the task described on the operation sheets is shown in the appropriate area. For assemblies, only the parts list will be specified unless expendable material such as solder, tape, epoxy, etc. are required. For machining operations, the raw material requirements are listed. The sequence of manufacturing steps was developed by the Production Engineer. He specifies the tools and test fixtures as well as the procedures and GR standards such as ESPM-243 and ESPM-200. The number XX-XX-XX reflects the skill, personnel classification and the grade level required for the operation respectively. However, only the skill and grade are necessary for planning the work. See Appendix G for additional details on skill, classification and grade levels.

The second column of numbers reflects the setup time in minutes for each lot and the third column represents the time in minutes for each operation. An operation sheet is issued with every lot released for fabrication or assembly.

TRACKING SERVO - BRIDGE DETECT
2995-9503
A75-L01

TRACKING SERVO - BRIDGE DETECT
2995-4855
PARTS LIST - 4855
-4855-2L, -4855-3L, -4855-4L
-4855-5L, -4855-6L, -4855-7L
-4855-8L, -4855-9L, -4855-10L
-4855-11L, -4855-12L, -4855-13L
A75



VO-BRIDGE DETECTOR COMPLETE
2995-9503
A75-L01

VO - BRIDGE DETECTOR ASM
2995-4855
LIST - 4855-1L
- 4855-3L, - 4855-4L
- 4855-6L, - 4855-7L
- 4855-9L, - 4855-10L
- 4855-12L, - 4855-13L
A 75

PARTS LIST
-OL 1

2995-9503 TRACKING SERVO-BRIDGE DETECTOR
FLOW DIAGRAM

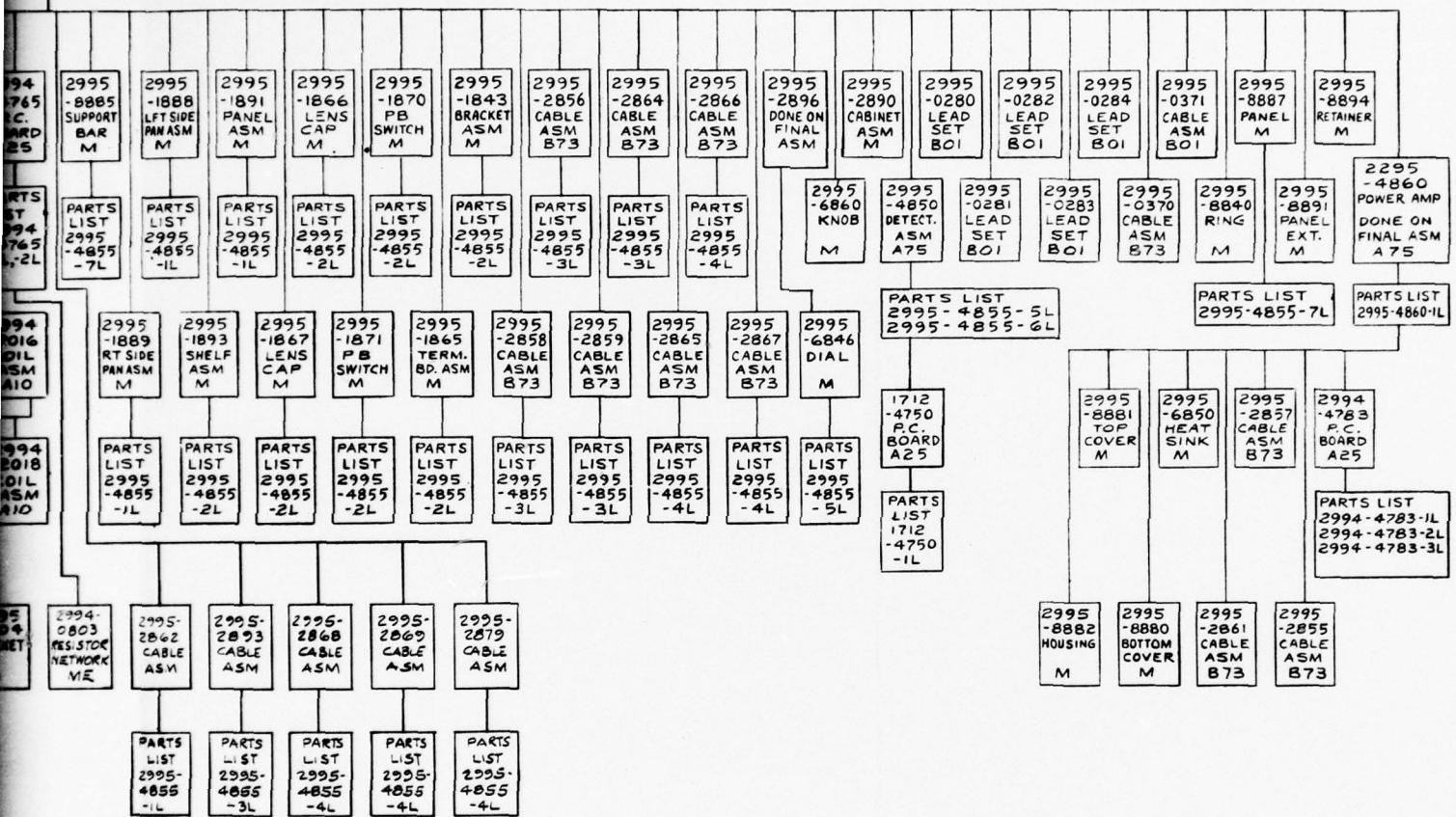


FIGURE 1. TRACKING SERVO BRIDGE DETECTOR - FLOW DIAGRAM

CIRCUIT BOARD FABRICATION FLOW DIAGRAM

For	Type No.	Description	Type No.	Description	Type No.	Description
2994-4765	R.F. Module and Main	2994-4783	R.F. Power Amp.	2994-4786	Gen. Isolation	
	Power Supply BD V	2994-4784	Ref. I.F. & Phase		Amp. Bd. GI	
2994-4766	Servo & Sweep BD SS		Shifter Bd Ps	2994-4787	L/O Isolation Amp.	
2994-4781	X10 Freq. Multiplier	2994-4785	X-Y Synchronous		Bd. LI	
			Detectors Bd SD	2994-4788	I.F. Amp. Bd. IF	

For Item No. and quantity
Ref. Part List

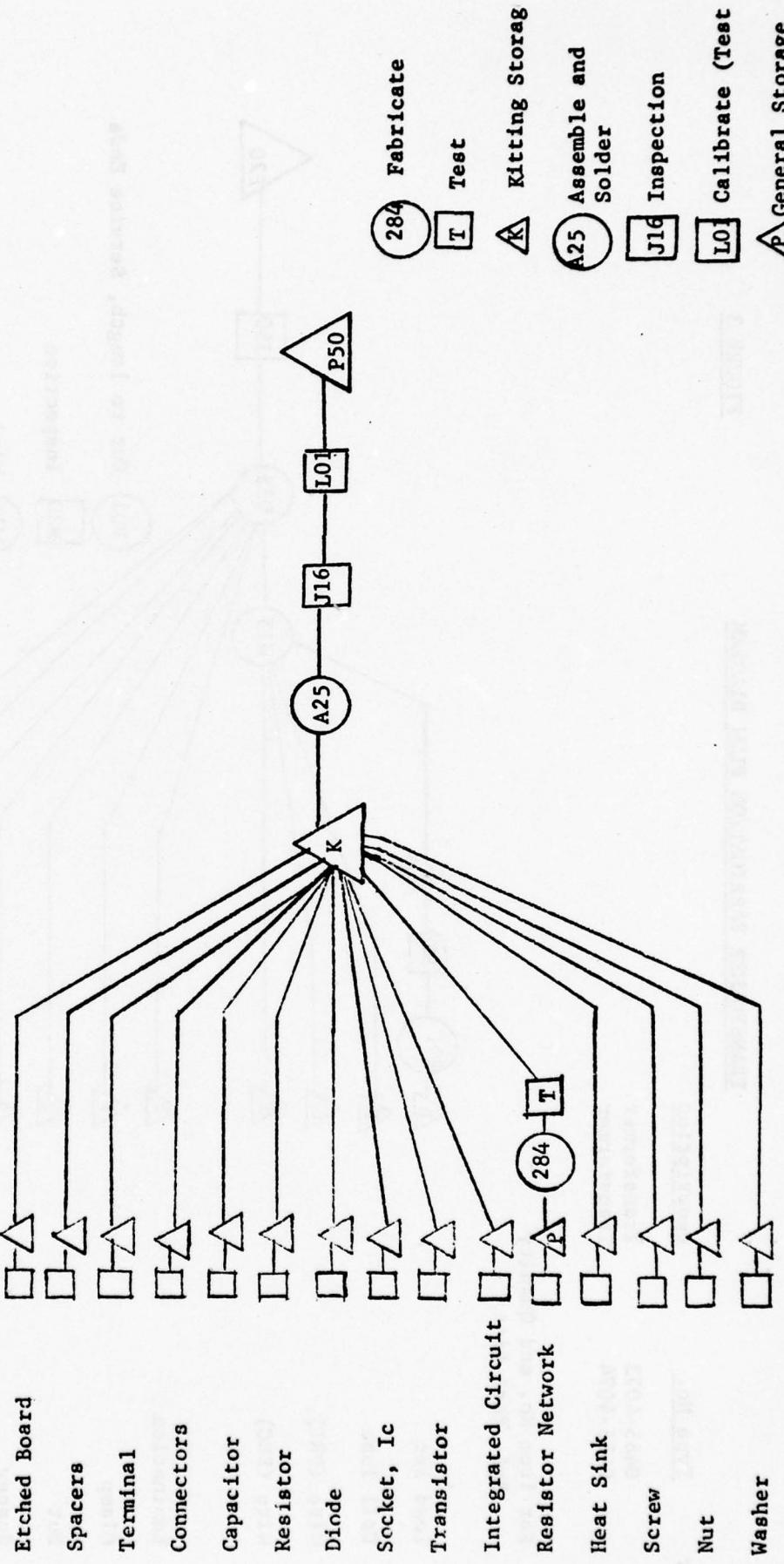
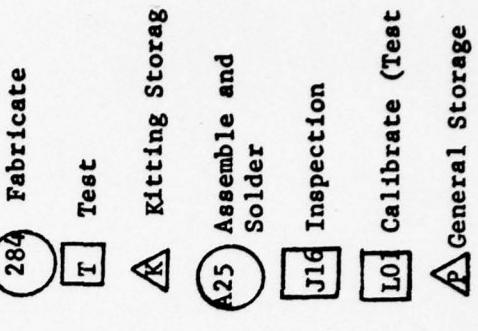


FIGURE 2



TRANSFORMER FABRICATION FLOW DIAGRAM

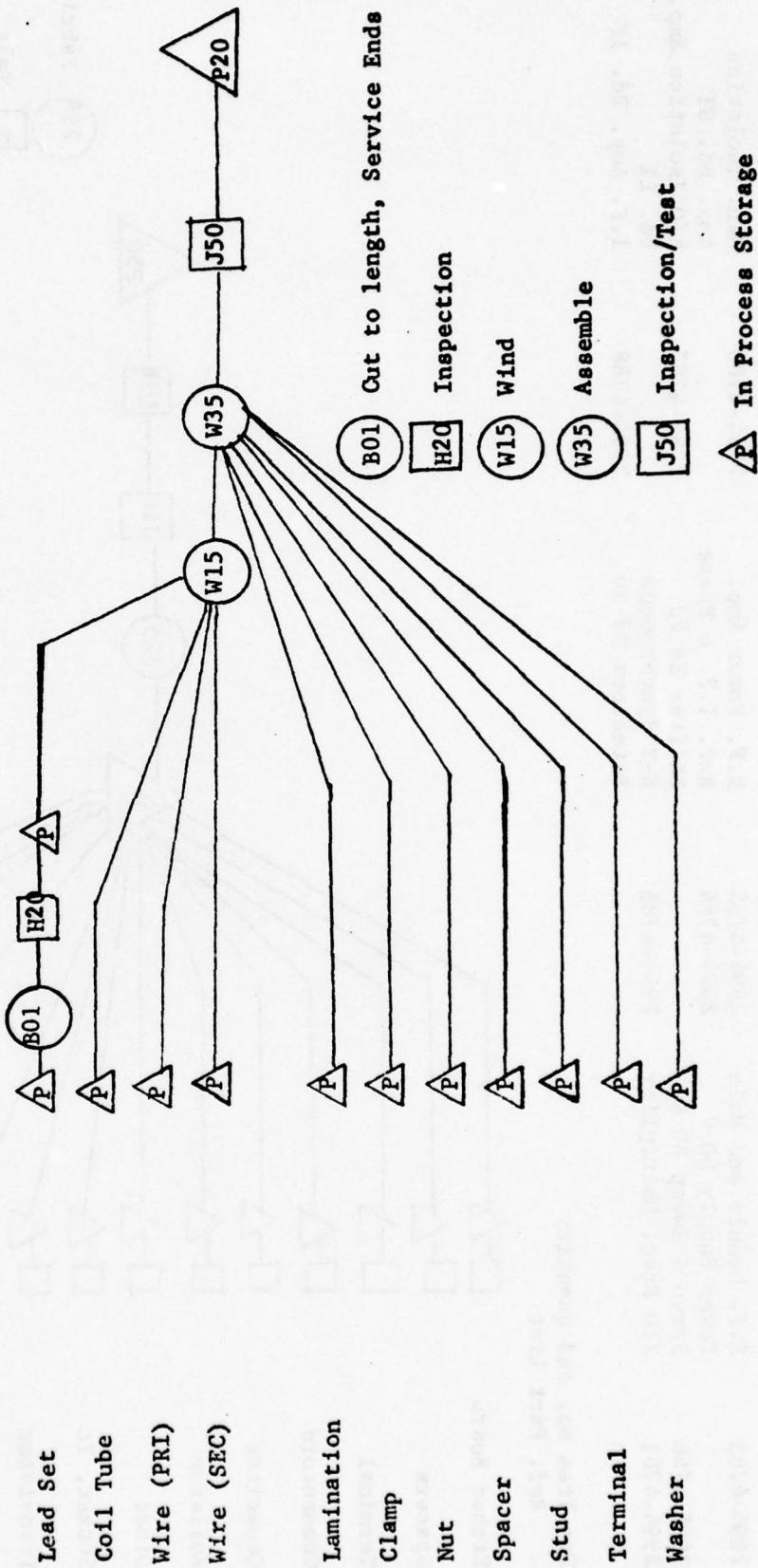
FIGURE 3

For Type No. Description

0485-4073	Transformer
0485-4074	Transformer

For Item No. and Quantity
Ref. Part List

Lead Set
Coil Tube
Wire (PRI)
Wire (SEC)



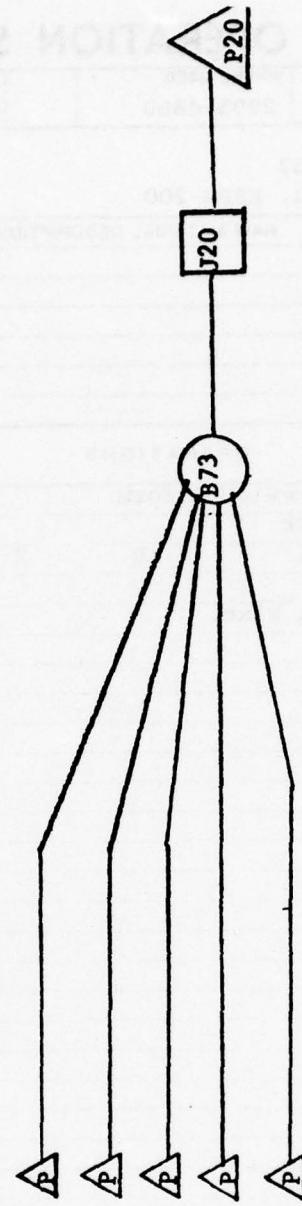
SEMI-RIDGE COAX CABLE ASSEMBLIES FLOW DIAGRAM

FIGURE 4

<u>Part No.</u>	<u>Description</u>						
2995-2855	Cable Assembly	2995-2865	Cable Assembly	2995-2879	Cable Assembly		
2995-2856	Cable Assembly	2995-2866	Cable Assembly	2995-2893	Cable Assembly		
2995-2858	Cable Assembly	2995-2867	Cable Assembly	2995-2861	Cable Assembly		
2995-2859	Cable Assembly	2995-2868	Cable Assembly	2995-2857	Cable Assembly		
2995-2864	Cable Assembly	2995-2869	Cable Assembly	2995-2862	Cable Assembly		

For Item No. and Quantity
Ref. Part List

<u>Part No.</u>	<u>Description</u>
33-1210	Cable (ESMU-46-2)
1165-6035	Bushing
1165-6040	Conc.
4220-0220	Plug
0864-4493	Connector



- △ General Storage
- △ Kitting Storage
- Component Assembly
- Inspect/Test
- △ In Process Storage

SHOP COPY

OPERATION SHEET

START DATE:

DUE DATE:

ORDER QUAN.	DRAFTING NO.	WHERE-USED		DATE	FILE NO.	L	PAGE	ITEM NUMBER
25		2995-4860						2995-2857

→ PRINTS
2995-2857
ESPM-243, ESPM-200 → OFFICE ORDER →

R/M NO.	RAW MATERIAL DESCRIPTION	UNIT	I/D	TOT. QUANTITY	UNIT WEIGHT
0033-1210	ESMW-46-2	Ft		.9'	
1165-6035	Bushing	Ea		2	
1165-6040	Cone	Ea		2	
4220-0210	Coax. Plug	Ea		1	
5305-0138	Solder Form	Ea		1	

PARTIAL QUANTITY RECORD

PRODUCTION PLANNING AND SCHEDULING

Detailed production planning was not performed on this contract. Schedules were prepared for the engineering phase and the pilot production run. The General Report covered advance production plans. GenRad prepared the basic ingredients for production plans as a part of this Production Engineering Measures Contract. The Work Breakdown Structure, Material Lists and the Operation Sheets are essential to the planning. Their use is explained in the following paragraphs.

Utilizing the labor grade and category contained on the Operation Sheets, an estimate of the total labor by job class can be prepared and compared to the available labor. Actual hours expended on the operation will vary depending on operator skill, interruptions and part quality.

Component lead times have been established based on actual experience in obtaining deliveries of the same or similar components. Because of the anticipated nature and size of the contract, orders for the full contract quantity, plus a yield factor based on our experience would be placed upon receipt of the production contract.

Schedule times are based on the labor estimate, component delivery times and subassembly/assembly lead times. Combined with the Process Flow Charts and the Milestone Charts, detailed schedules can be prepared as necessary.

Planning during the Engineering phase was more difficult. Not only was it necessary to determine the entire content of work required, but allowances for design changes should be planned or schedule slippages will occur. The engineering phase, however, was planned on the so-called "optimistic" basis which allowed only minimal time for contingencies.

In the Pilot Production phase to conserve time, many subassembly operations were overlapped with the first article testing. This technique, although more costly, permitted the program to be completed more expeditiously than otherwise would have been possible.

VI.

SPECIAL TOOLING

As the printed circuit board artwork was designed, photomasters were produced in the usual manner and are retained in GenRad's document control system. As machined pieces were designed, drill fixtures, forming fixtures and numerical control tapes for use on automatic equipment were designed and fabricated under the supervision of the manufacturing engineer. These tools are being retained under procedures established in our Tool Control System. There were no unusual tooling requirements on this program. The list of the special tools is included as Appendix E.

VII.

TEST EQUIPMENT

Because the basic circuitry of the Tracking Servobridge Detectors is commonplace, most of the test equipment required was readily available, including the following standard, commercial items:

Spectrum Analyzer
RF Power Meter
Frequency Counter
Oscilloscope
Synthesizer

However, test fixtures and jigs were required for testing and aligning subassemblies. These fixtures were generally simple and easily designed. The test fixtures fabricated for this contract are shown as Appendix F. At the present time, they are being maintained at our facility in Bolton, Massachusetts.

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VIII.

SPECIFICATION

A review of the data and the specification does not indicate any requirement which must be changed. However, a nominal reduction of 1.0 dB between 10 and 20 MHz in the RF power output specification will ensure the excessive effort was not spent on peaking the amplifiers. A change to -150 dBm (between 0.8 - 150 MHz) and to -145 dBm (between 150-220 MHz) in the permitted leakage will reduce assembly, test, debug and retest time. These changes ought not to impair the utility of the Tracking Servobridge Detector in a quartz crystal measuring system.

IX.

DATA AND ANALYSIS

The results of the First Article testing have been reported previously. Volume I discusses the design performance of selected units. The two serious problems encountered during the pilot model phase were concerned with RF leakage and transformer hum. These problems were analyzed and fixes installed in the pilot production models. The data on these units indicate that the changes were completely satisfactory.

The RF amplifier power output requirements were achieved only with added cost for components and a greater power dissipation than originally estimated. The results are shown in Table I.

The other parameters of greatest significance are receiver gain and sensitivity and leakage. Table II and III demonstrate that the pilot production models met or exceeded requirements.

TABLE I

RF Power Out (with 0 dBm input)

Freq.	.8	5	10	20	50	100	200/220	MHz
Unit								
#5	29.5	29.6	29.5	29.2	28.0	27.0	25.0	dBm
#6	30.6	30.2	30.0	29.8	29.0	28.3	26.2	dBm
#7	29.6	29.5	29.1	28.2	27.2	26.4	26.3	dBm
#8	30.1	30.0	29.9	29.4	28.2	27.2	25.4	dBm
#9	30.2	30.2	30.0	29.6	28.3	27.1	25.3	dBm
#10	30.2	30.1	29.8	29.3	27.8	26.8	25.3	dBm
#11	29.8	29.7	29.6	29.3	27.8	26.8	25.0	dBm
#12	30.0	29.9	29.8	29.5	28.8	27.8	25.5	dBm
#13	29.2	29.2	29.2	29.1	28.4	27.4	25.8	dBm
#14	29.6	29.6	29.6	29.4	28.6	28.0	26.2	dBm
#15	29.2	29.6	29.8	29.2	27.7	26.4	25.0	dBm
Average	29.8	29.8	29.7	29.3	28.2	27.2	25.5	dBm

Specifi-								min
cation	29.0	29.0	29.0	29.0	24.0	24.0	24.0	dBm

TABLE II

RECEIVER GAIN & SENSITIVITY

<u>Serial Number</u>	<u>I.F. Step</u>	<u>Gain Variable</u>	<u>Equivalent Noise Level dBm</u>
5	9	2	-156
6	9	5	-155
7	9	1	-155
8	9	4	-155
9	9	5	-155
10	9	2	-155
11	9	2	-155
12	9	1	-155
13	9	2	-155
14	9	2	-155
15	9	2	-155

Specification Must be sufficient to produce required output indication.
 Max gain at:
 9 9

Notes: Gain specification calls for a 12 division meter deflection on expanded scale for -120 dBm input. Gain settings shown above result in 12 division meter deflection on non-expanded scale. Actual performance therefore exceeds specifications by about 30 dB.

Noise specification calls for less than 2 divisions peak-to-peak fluctuation on the 12 division deflection which corresponds to an equivalent input noise level of about -145 dBm. Actual performance exceeds this by about 10 dB.

TABLE III

LEAKAGE

<u>Serial Number</u>	<u>Maximum observed at any frequency between 0.8 to 150 MHz</u>	<u>Maximum observed at any frequency between 150 to 220 MHz</u>
5	-153 dBm	-152 dBm
6	-150	-150
7	<-155	-153
8	<-155	-145
9	<-155	-150
10	<-155	-147
11	<-155	-153
12	<-155	<-155
13	<-155	-145
14	<-155	-153
15	<-155	-152
Specification	<-148 (less than)	

Note: Leakage specification calls for a maximum meter deflection of 0.5 division when the gain is adjusted to produce a deflection of 12 division for a -120 dBm input. The maximum equivalent input leakage level is therefore -148 dBm. All units easily meet this requirement below 150 MHz. Most units also meet this requirement above 150 MHz. The two units that exceeded the leakage spec were did so by only a very few dB and only a very few spot frequencies around 200 MHz.

X.

REQUIREMENT FOR PILOT PRODUCTION LINE

Due to the nature of the Tracking Servobridge Detector and its assembly, no pilot production line, as commonly understood, was set up. The subassemblies were assembled, wave soldered and inspected, but were delivered untested to the final assembly, test and calibration area. Mechanical parts and other components were also delivered to the same area.

This area, approximately 22' x 70', is air conditioned and contains ten work benches (8 ft. x 29 in.) and storage space. There was sufficient room to set up the equipment to test the subassemblies and the units and to perform final assembly.

Personnel requirements included the project engineer, the design engineer, production and test engineer, test technician and assembler. A draftsman was available to document required changes in drawings.

No permanent or semi-permanent setups of equipment were required. Final assembly required only ordinary hand tools and soldering irons. The requirements for test fixtures and test equipment was discussed in Section VII.

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XI. COMPARISON OF ESTIMATED COSTS WITH ACTUAL PILOT COSTS

	<u>Estimated Cost (for 10)</u>	<u>Actual Costs (for 10)</u>
Direct Material	\$21,700	\$23,800
Direct Labor	\$22,418	\$27,166
Direct Labor	Hours - 4,183	Hours 4,453

XII.

QUALITY ASPECTS

GenRad maintains a Quality System which exceeds the requirements of MIL-I-45208A. Our corporate quality policies, activities and controls are documented in a Quality Manual. The policies are implemented by detailed procedures and plans as required by the nature of the product or special contractual requirements. No special inspection procedures were needed for the Tracking Servobridge Detector.

Table IV summarizes the defects on the pilot production units. They are categorized in accordance with the definitions contained in Appendix H. The Acceptable Quality Level (AQL) for various components is shown in Appendix I.

The field failures and repetitive defects are as follows:

COMPONENT FAILURES

1. A number of the commonly used 4.7 μ f, 25v electrolytic capacitors had early life shorts. General company experience with this component has been acceptable. Bad lot is most likely explanation, although voltage stress may be a factor as most are run at 18v. An increase in derating might be desirable, if additional failures occur during normal field operations.
2. Several Nippon RF power transistors had early life failures in the RF power amplifier assembly. No definite explanation has been found. No field failures, however, have been reported.

WORKMANSHIP

1. One production unit has returned to factory because the synchronous detectors did not work. The problem was the reference IF signal input was open. An analysis indicated that the coax center conductor was never soldered and had been making only a mechanical connection.

DESIGN ERRORS

1. Several field failures resulted from 4.7 μ f, 25v electrolytics which were installed backwards. Polarity was drawn incorrectly on schematic. Boards with the correct component polarity were shipped to the field to replace all faulty assemblies.
2. The remote \emptyset - shifter wiring was wrong on all production units because the assembly drawings were incorrect.

Instructions to rework in field have been provided.

TABLE IV

QUALITY DEFECTS

Where Detected	Workmanship				Material		General	
	A	B	C	D	Purch.	Mfg.	Design	Drwg.
Subassembly Inspection and Test (No. of occurrences)	0	6	2	-	10*	1	-	-
Assembly Inspection (No. of type defects)	-	-	5	2	1	-	-	2
Assembly Test (No. of occurrences)	1	1	2	4	9*	0	2	-
Field (including Reliability) (No. of Type Failures)	1	-	-	-	2*	-	1	1

*All workmanship and material defects random except following:

- (1) 4.7 μ f, 25v electrolytic capacitors.
- (2) RF power transistors
- (3) Crystals - (temperature coefficient and specification tolerance)
- (4) Meter (sticky) (Vendor assembly problem)

"The following field failures have been noted by the Electronics Technology and Devices Laboratory of the United States Army Electronics Command.

<u>Defect</u>	<u>No. of Units</u>
+18 Volt Supply	2
-18 Volt Supply	1
-5.2 Volt Supply	1
-22 Volt Supply	1
10 Turn Potentiometer Dial	1
Power On Indicator	4
Reference IF Board	3
RF Amplifier	2
Multiplier Alarm Circuit	1
Generator Isolation Module	2
Mode Switch	1
RF Meter	

The exact cause of some of the above failures has not been isolated at this time.

XIII.

PROGRAM REVIEW AND CONCLUSIONS

This contract had as an objective the development of the production engineering measures necessary to build Tracking Servobridge Detectors by production techniques and procedures. The PE measures would permit the more economical production of the required units and in a reduced time. The Tracking Servobridge Detectors would support the fabrication and test of quartz crystal oscillators.

Although an exploratory development model existed at the start of the contract, it was necessary to perform a significant design effort prior to commencing the pilot production run. The detailed design of the unit is reported in Volume I. There were several difficult technical aspects including internal RF leakage and drift rate of the servo integrator. As reported in Section IX, the pilot production models met or exceeded all of the technical requirements.

As indicated by the cost reviews, the units were fabricated at costs not excessively larger than originally estimated and are now estimated to cost, if manufactured at a rate of 25 per month, approximately one-third of the pilot production cost (labor). Because the unit was designed basically using readily available, off-the-shelf, commercial components, no large savings in material costs would be realistic in volume production. Nevertheless, the total cost was reduced approximately 50%.

The availability of a desirable piece of electronic test equipment, the reduction in cost and the development and confirmation of the procedures, drawings, operation sheets and associated equipment for pilot model fabrication are evidence of the successful completion of a Production Engineering Measures contract.

XIV.

RECOMMENDATIONS FOR FUTURE WORK

The work performed on this contract has contributed to the potential for better quartz crystal measurements, particularly, as regards their basic parameters and, therefore, ultimately more accurate, stable and precise crystal oscillators. Other components of the system must be developed, such as improved RF bridges, bridge autobalancing units, and offset local oscillators. The RF bridge, in particular, appears to offer an opportunity for significant improvement as a result of a development program. The bridge autobalancing unit would appear amenable to incorporation of a calculator. The calculator will speed the operation and permit the mathematical correction of residual errors in the bridge itself.

The design Offset Local Oscillator is judged to be satisfactory for manufacture of pilot production models. Mechanical design is required for the RF shields, as well as artwork changes to reflect all circuitry changes and complete drawings would also be required prior to fabrication.

The Tracking Servobridge Detector, however, is now ready to manufacture in production quantities. Simultaneously, with the initial phases of the production order, a reliability and maintainability review ought to be performed. This review might indicate desirable changes in components. In addition, a comparison of the components utilized in the pilot models with currently available components might indicate that more reliable or higher quality components will be available at cost savings. Although GenRad chose standard components to the maximum degree possible, if a significant time were to elapse between the PEM and a production contract, this review might be necessary in order to obtain useable components quickly.

Before production is initiated a review and analysis of interface requirements should be performed. GenRad expects that this review will occur as the other elements in the crystal measuring system are developed. Nevertheless, the interface drawings and specifications should be reviewed to reflect current requirements and compatibility with the ancillary equipment. At the time of preparation of this report, it is known that the -5.2v power supply current limiter should be modified to accommodate the Offset Local Oscillator.

Although a preliminary operating instructions manual was prepared, consideration should be given to preparation of a complete, detailed manual suitable for printing.

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XV.

PROGRAM COST REVIEW

Withheld from General Distribution. Refer to
Appendix J in ERADCOM and DELCD-PC copies.

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APPENDIX A

INDENTURED PARTS LIST

PARTS LIST

SHEET 1 OF 1

INSTRUMENT 2995-9503 TRACKING SERVO-BRIDGE DETECTOR.

	PART DESCRIPTION	REF. INFO.	PART NO.	REQ.	DWG.NO.																
1	LEVEL																				
2																					
3	0 Tracking Servo-Bridge Detector		2995 9503																		
4																					
5																					
6																					
7	1 Tracking Servo-Bridge Detector (All)		2995 4855	1																	
8																					
9	1 Instruction Book (All)		2995 0102	1																	
10																					
11	1 U Line Section 874-U		0874 9528	1																	
12																					
13	1 Fixed Atten. 874-GLOL (10dB)		0874 9571	1																	
14																					
15	1 Locking Adaptor 874-QMMJL		0874 9723	2																	
16																					
17	1 50Ω Termination (Locking) 874-W50FL		0874 9955	2																	
18																					
19	1 Locking Adaptor 900-9874		900 9883	1																	
20																					
21																					
22																					
23	1 Reel Kit		2995 0544	1																	
24																					
25	1 Cable Power 3 Wire (CPE Std.)		4200 9625	1																	
26																					
27	1 Fuse Slo-Blow 1/4A 250V		5330 0700	1																	
28																					
29	1 Fuse Slo-Blow 1/2A 250V		5330 1000	1																	
30																					
31																					
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2995-9503-01/3																					
GENERAL RADIO COMPANY CONCORD, MASSACHUSETTS		<table border="1"> <tr> <td>NUMBER 2995-9503-01/3</td> <td>FILE C</td> <td>DATE 11-11-74</td> <td>ISSUE 1</td> </tr> <tr> <td colspan="4">REVISIONS</td> </tr> <tr> <td colspan="4">PARTS LIST TYPE NO. CHG. MEN 3-17-75 CLS 1/21 INS WAS 9874-21 21 KIR MEN 3-26-75 CLS 1/21 2</td> </tr> <tr> <td colspan="4">CN 23 DELETED WJR 9-3-75 X 1/21 3</td> </tr> </table>				NUMBER 2995-9503-01/3	FILE C	DATE 11-11-74	ISSUE 1	REVISIONS				PARTS LIST TYPE NO. CHG. MEN 3-17-75 CLS 1/21 INS WAS 9874-21 21 KIR MEN 3-26-75 CLS 1/21 2				CN 23 DELETED WJR 9-3-75 X 1/21 3			
NUMBER 2995-9503-01/3	FILE C	DATE 11-11-74	ISSUE 1																		
REVISIONS																					
PARTS LIST TYPE NO. CHG. MEN 3-17-75 CLS 1/21 INS WAS 9874-21 21 KIR MEN 3-26-75 CLS 1/21 2																					
CN 23 DELETED WJR 9-3-75 X 1/21 3																					
40																					
CPO REL FOR PRODUCTION DATE 11/11/74 ON APP.																					
																					
ISSUE																					

PARTS LIST

SHEET 1 OF 2

INSTRUMENT RF MODULE & MAIN POWER SUPPLY BOARD 2994-4765

	PART DESCRIPTION	REF. INFO.	PART NO.	REQ.	DWG. NO.
1	RF MODULE & MAIN POWER SUPPLY BOARD (V)		2994 4765	1	
2	RF MODULE & MAIN POWER SUPPLY BD SOLDERED		2994 2765	1	
3	RF MODULE & MAIN POWER SUPPLY BD ASM		2994 1765	1	
4	Etched Board		2994 0765	1	A.B.C
5	Spacer		2995 6855	6	
6	Terminal Turret	WT1 thru WT15	7970 2700	15	
7	Connector, Jack		4260 1291	8	
8	Connector, Link	WT16 17 18 19	5080 1250	4	
9	Connector, Link	C11	5080 1260	1	
10	Cap. Cer. 0.1u ±10% 100V		4400 6350	1	
11	Cap. Cer. 100pF ±5% 100V	C3, C5	4400 6442	2	
12	Cap. Electrolytic 22μf 35V	C4, 9, 10	4450 5612	3	
13	Cap. Electrolytic 120μf 10V	C6	4450 5616	1	
14	Cap. Electrolytic 4800μf 15V	C2	4450 4200	1	
15	Cap. Electrolytic 3350μf 35V	C1	4450 7420	1	
16	Cap. Electrolytic 2200μf 35V	C7, C8	4450 7430	2	
17	Resistor Network, Microelectronics	Z1 (R12 thru R16)	2994 0803	1	
18	Res., Wire Wound	R20, R23	6058 1105	2	
19	Pat., Wire Wound	R11	6058 2105	1	
20	Rectifier 1N4140	CR1 thru CR8			
21	Zener 1N958B 7.5V 5% .4W	CR10 thru CR13	6081 1014	12	
22	Rectifier Diode 1N825	CR20	6083 1057	1	
23		CR9	6083 1060	1	
24					
25					
26					
27					
28					
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31					
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NUMBER 2994-4765-12/18	SCALE BLD	FIRST USED ON 2/25/65	DR. CH. APP.
GENERAL RADIO COMPANY CONCORD, MASS. U.S.A.			

FILE DATE 7-1-74	REVISIONS LN 21 WHICH WAS 1225 PT NO WAS 4450-6115 WJR 12-5-74 ADDED LN 15 WAS 4400-6442 WJR 5-22-75 CUST LN 6 WAS 1105-6017 WJR 4-26-75 MEN 7-30-75 LN 34 ADDED WJR 9-2-75 LN 12 ADDED; LN 32 1N4140 WAS 1N4003 6081-1014 " 6081-1014 WJR 4-26-75 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45
ISSUE	2994-4765-12/18

PARTS LIST

SHEET.....2.....OF....2

INSTRUMENT RF MODULE & MAIN POWER SUPPLY BOARD 2994-4765

	PART DESCRIPTION	REF. INFO.	PART NO.	REQ.	DWG. NO.
1					
2					
3	Resistor Comp $100\Omega \pm 5\%$ 1/4W	R3,8	6099 1105	2	
4	Resistor Comp $200\Omega \pm 5\%$ 1/4W	R25	6099 1205	1	
5	Resistor Comp $1K\Omega \pm 5\%$ 1/4W	R2,7,4	6099 2105	3	
6					
7	Resistor Comp $1.5K\Omega \pm 5\%$ 1/4W	R9	6099 2155	1	
8					
9	Resistor Comp $1.8K\Omega \pm 5\%$ 1/4W	R6	6099 2185	1	
10					
11	Resistor Comp $3.9K\Omega \pm 5\%$ 1/4W	R1	6099 2395	1	
12					
13	Resistor Molded $0.62\Omega 5\%$ 2W	R5	6760 8625	1	
14	Resistor Molded $0.39\Omega 5\%$ 2W	R10	6760 8395	1	
15	Resistor Molded $1\Omega 5\%$ 2W	R18	6760 9105	1	
16					
17	Resistor Film $137\Omega 1\%$ 1/4W	R22	6350 0137	1	
18					
19	Resistor Film $90\Omega 1\%$ 1/4W	R21	6350 9900	1	
20					
21	Resistor Film $920\Omega 1\%$ 1/2W	R19,24	6450 0920	2	
22					
23	Socket, IC	XU1, XU2	7540 3461	2	
24					
25	Transistor 2N2369	Q2,4	8210 1052	2	
26					
27					
28	Integrated Circuit LM101A	U1,2	5432 1020	2	
29					
30	Integrated Circuit LM320K-15	U4	5432 1051	1	
31					
32	Integrated Circuit LM340K-15	U3	5432 1052	1	
33					
34	Transistor TIP-641	Q1,3	8210 1235	2	
35					
36	Terminal	.	7930 2100	4	
37					
38	Heat Sink	.	6070 0250	4	
39					
40	Screw .138-32 3/8	.	7070 1700	24	
41	Nut	.	5810 2400	24	
42	Washer	.	8040 1800	24	
43					
44					
45					

APPENDIX B
VENDOR SOURCE LIST

APPENDIX BVENDOR SOURCE LIST

<u>4X4 P/N</u>	<u>Description</u>	<u>Vendor</u>	<u>Remarks</u>
5360-2017	Handles	Boyd Coating Research Co. Gleasondale, Ma.	Finishing
2995-9999	Screwdrivers	Boyle Machine Supply Co.	
2995-0549	Tool Kits	Allied Electronics Braintree, Ma.	
2995-0544	Multidial	Cramer Electronics Newton, Ma.	
2995-0543	Lens Cap	Cramer Electronics Newton, Ma.	
2995-0540	P/B Switches	Cramer Electronics Newton, Ma.	
2995-0542	Attenuator	Kay Electronics Corp. Pinebrook, N.J.	
2995-5102	Transistor	California Eastern Labs Burlington, Ma.	
6084-1038	Diodes	Alpha Industries Woburn, Ma.	
6084-1039	Diodes	Alpha Industries Woburn, Ma.	
5431-9668	Int. Circuits	Plessey Semiconductors Natick, Ma.	
2995-0546	Transformer	Anzac Waltham, Ma.	
2995-0547	Cores	Cambridge Thermionic Corp. Cambridge, Ma.	
6070-0250	Heatsinks	Wakefield Engineering Wakefield, Ma.	
2995-0540	Switches	Cramer Electronics Newton, Ma.	
2995-0545	Termination	Blake Associates Medford, Ma.	
5415-1010	Heatsink stand-off	Cramer Electronics Newton, Ma.	

APPENDIX B

VENDOR SOURCE LIST

- 2 -

<u>4X4 P/N</u>	<u>Description</u>	<u>Vendor</u>	<u>Remarks</u>
7970-2740	Terminals	Cramer Electronics Newton, Ma.	
6070-0410	Heatsinks	Wilshire Electronics/N.E. Burlington, Ma.	
	Brass	Millard Metal Service Ctr. Type 342 1/2 H Boston, Ma.	
7997-0103	Transformer	Vari-L Co. Denver, Colo.	
	Steel Rod	Edgecomb Steel of N.E. Type B-112 or B-113 Nashua, N.H.	
2995-0534	Filters	Milgray Electronics Burlington, Ma.	
4220-0210	Osm Conn'r Plugs	Blake Associates Medford, Ma.	
2995-6845	Dial Asm.	M & V Electro Plating Co. Finishing Newburyport, Ma.	
4400-6521	Capacitor	Centre Engineering Inc. State College, Pa.	
4400-6522	Capacitor	Centre Engineering Inc. State College, Pa.	
4410-1221	Capacitor	Centre Engineering Inc. State College, Pa.	
4450-6533	Capacitor	Mallory Capacitor Co. Watertown, Ma.	
6058-1105	Potentiometer (leaded bronze)	Cramer Electronics Newton, Ma.	
0970-0677	Terminals	Madel Inc. Greenville, Rhode Island	
5432-1051	Int. Circuit	Kierulff Electronics Inc. Billerica, Ma.	
5432-1052	Int. Circuit	Kierulff Electronics Inc. Billerica, Ma.	
5431-9671	Int. Circuit	Hamilton Avnet Electronics Burlington, Ma.	

APPENDIX B

VENDOR SOURCE LIST

- 3 -

<u>4X4 P/N</u>	<u>Description</u>	<u>Vendor</u>	<u>Remarks</u>
5432-1041	Int. Circuit	Hamilton Avnet Electronics Burlington, Ma.	
2994-5173	Int. Circuit	Hamilton Avnet Electronics Burlington, Ma.	
5431-9670	Int. Circuit	Cramer Electronics Newton, Ma.	
5431-9669	Int. Circuit	Cramer Electronics Newton, Ma.	
2994-5171	Int. Circuit	Raytheon Burlington, Ma.	
4400-6351	Capacitor	Erie Tech. Products Lakeside Office Pk. Wakefield, Ma.	
5730-6201	Meters	Jewell Electrical Insts. Inc. Manchester, N. H.	
5730-6202	Meters	Jewell Electricals Insts. Inc. Manchester, N.H.	
5730-6203	Meters	International Insts. Division Orange, Connecticut	
5075-1100	Crystals	Reeves Hoffman Carlisle, Pa.	
5000-7704	Bobbin	North American Phillips Corp. Waltham, Ma.	
5000-4220	Hardware Set	North American Phillips Corp. Waltham, Ma.	
5000-7828	Matched Core Set	North American Phillips Corp. Waltham, Ma.	
2994-5167	ICP	Inselek Inc. Princeton, N.J.	
2994-5168	ICP	Inselek Inc. Princeton, N.J.	
6090-1403	Relays	Electronic Instrument & Specialty Stoneham, Ma.	

APPENDIX B

VENDOR SOURCE LIST

- 4 -

<u>4X4 P/N</u>	<u>Description</u>	<u>Vendor</u>	<u>Remarks</u>
2994-5170	Transistors	General Instruments Corp. Hicksville, N.Y.	
2994-5169	Hy-byrd Power Splitter	Mini Circuits Lab Inc. Brooklyn, N.Y.	
6082-1051	Diode	Hewlett-Packard Co. Lexington, Ma.	
6082-1053	Diode	Hewlett-Packard Co. Lexington, Ma.	
4450-6531	Capacitor	Mallory Capacitor Co. Watertown, Ma.	
4300-	Chokes	Lenox-Pugle Electronix Inc. Plainfield, N.J.	270 μ ±10%
4300-6373	Chokes	Lenox-Pugle Electronix Inc. Plainfield, N.J.	330 μ ±10%
4300-	Chokes	Lenox-Pugle Electronix Inc. Plainfield, N.J.	390 μ ±10%
4300-4900	Chokes	Lenox-Pugle Electronix Inc. Plainfield, N.J.	560 μ ±10%
4300-4700	Chokes	Lenox-Pugle Electronix Inc. Plainfield, N.J.	820 μ ±10%
6045-3430	Pots	Cramer Electronics Newton, Ma.	
6030-0500	Pots	Allen Bradley	PO 77316-H
7890-6201	Rotary Switch	Oak Industries Crystal Lake, Ill.	
	Push Buttons	Cramer Electronics Newton, Ma.	Licon P/N 03-9113 PO 77496 (PO 40)
6060-0300	Oiled Pot.	Spectrol Lexington, Ma.	
2995-8841	Transformer Shields	Lindberg Heat Treating Co. So. Boston, Ma.	
2995-8908	Transformer Shields	Lindberg Heat Treating Co. So. Boston, Ma.	

APPENDIX B

VENDOR SOURCE LIST

- 5 -

<u>4X4 P/N</u>	<u>Description</u>	<u>Vendor</u>	<u>Remarks</u>
6058-2105	Potentiometer	Wilshire Electronics Burlington, Ma.	
2994-5172	Int. Circuit	Kierulff Electronics Billerica, Ma.	
7110-1477	Screw	The Jacques Co., Inc. Boston, Ma.	
7110-6001	Screw	The Jacques Co., Inc. Boston, Ma.	
7110-6003	Screw	The Jacques Co., Inc. Boston, Ma.	
7110-6004	Screw	The Jacques Co., Inc. Boston, Ma.	
7110-6043	Screw	The Jacques Co., Inc. Boston, Ma.	
2995-0566	Op Amps	Burr Brown Wakefield, Ma.	
2995-0560	Switches	Impact Sales Co., Inc. Waltham, Ma.	
2995-0561	Push Buttons	Impact Sales Co., Inc. Waltham, Ma.	
2995-0562	Switches	Wilshire Electronics Burlington, Ma.	
2995-1870	Push Buttons	Wilshire Electronics Burlington, Ma.	
2995-1871	Push Buttons	Wilshire Electronics Burlington, Ma.	
2995-0564	Lamps	Wilshire Electronics Burlington, Ma.	
2995-0563	Lamps	Wilshire Electronics Burlington, Ma.	
2995-8885	Support Bars	M & V Electro Plating Newburyport, Ma.	Chromating Plating
2995-2897	Tool Shrouds	M & V Electro Plating Newburyport, Ma.	Chromating Plating

APPENDIX B

VENDOR SOURCE LIST

- 6 -

<u>4X4 P/N</u>	<u>Description</u>	<u>Vendor</u>	<u>Remarks</u>
7629-0060	Spacer Rings	M & V Electro Plating Newburyport, Ma.	Chromating Plating
7629-0100	Spacer Rings	M & V Electro Plating Newburyport, Ma.	Chromating Plating
7629-0080	Spacer Rings	M & V Electro Plating Newburyport, Ma.	Chromating Plating
7640-0800	Spacers	M & V Electro Plating Newburyport, Ma.	Chromating Plating
7640-1000	Spacers	M & V Electro Plating Newburyport, Ma.	Chromating Plating
7640-1600	Spacers	M & V Electro Plating Newburyport, Ma.	Chromating Plating
7640-0700	Spacers	M & V Electro Plating Newburyport, Ma.	Chromating Plating
1712-8130	Support	M & V Electro Plating Newburyport, Ma.	Chromating Plating
2995-9999	Brackets	M & V Electro Plating Newburyport, Ma.	Chromating Plating
2995-1891	Front Panels	M & V Electro Plating Newburyport, Ma.	Chromating Plating
2995-2898	Transformer Shield	Lindberg Heat Treating Co. So. Boston, Ma.	
	Transformer	Vari-L Company Denver, Colorado	PO 81503

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APPENDIX C

OPERATION SHEETS
(Samples)

SHOP COPY

OPERATION SHEET

START DATE:

DUE DATE:

PARTIAL QUANTITY RECORD

SHOP COPY

OPERATION SHEET

START DATE: _____

PARTIAL QUANTITY RECORD

SHOP COPY

OPERATION SHEET

START DATE:

DUE DATE:

ORDER QUAN.	DRAFTING NO.	WHERE USED	DATE	FILE NO.	L	PAGE	ITEM NUMBER
25		2995-4855					2995-2887
→	PRINTS	2995-2887, 2995-2887-1L			OFFICE ORDER →		
R/M NO.	RAW MATERIAL DESCRIPTION	UNIT	I/D	TOT. QUANTITY	UNIT WEIGHT		
2995-2886	Tray Asm	ea		1			
1165-0401	Eyelet	ea		12			
1165-1849	Contact Strip Asm	ea		1			
1165-1852	Contact Strip Asm	ea		1			
2995-1840	Contact Strip Asm	ea		2			
2995-1841	Contact Strip Asm	ea		1			
2995-1850	Contact Strip Asm - OPERATIONS -	ea					
1165-18020	RF Insert	ea		2			
1165-8770	Capacitor	ea		6			
4300-7556	Choke, molded 220 μ H \pm 10%	ea		2			
4450-6531	Cap., Tant. 4.7 μ G \pm 20%, 25V	ea		2			
5280-1253	Filter, Elec, L.P. 100 MHz	ea		2			
5810-3100	Nut, Hex. 164-32	ea		2			
7110-1495	Screw, Cap .138-32 X .312	ea		2			
2995-1903	Septum Asm	ea		1			
2995-6880	Insert	ea		2			
7940-0600	Terminal	ea		2			
B70 A	Asm per ESPM-151-1, 1.0 and 1.1 less soldering and per ESPM-151-2, 5.0 and 5.1 less soldering						
	02-82-04	45	2.05	Ea S			
Tool	8986-2830 Punch and Anvil	B70					
Tool	8986-2815 Punch and Anvil	B70					
B73 B	Asm per ESPM-151-2, 6.0, 6.1, and 6.4 less solder Solder per ESPM-151-1, 1.1, ESPM-151-2, 5.1 and 6.1 When above operations are complete, solder per ESPM-151-2, 6.2, and ESPM-151-3, 9.3 Asm chokes, caps, and filters Asm per ESPM-151-4, 11.0, 11.1, 11.2 Pack to prevent damage Freon clean and repack						
	02-82-04	35	4.50	Ea S			
H20 C	Inspect and repack						
P50							

PARTIAL QUANTITY RECORD

FROM	TO	NO. OF PCS.	INSP. & DATE	CLOSE SHORT

FROM	TO	NO. OF PCS.	INSP. & DATE	CLOSE SHORT

SHOP COPY

OPERATION SHEET

START DATE:

DUE DATE:

Page 1

ORDER QUAN.	DRAFTING NO.	WHERE USED	DATE	FILE NO.	L	PAGE	ITEM NUMBER
25		2995-4855					2995-2890

→	PRINTS	2995-2890-1L	2995-4855-5L	2995-2890	OFFICE ORDER →
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R/M NO.	RAW MATERIAL DESCRIPTION				UNIT	I/D	TOT. QUANTITY	UNIT WEIGHT
10 1315	AL .125X36X48	3003	H14		\$/50	IN	1561	lbs 11 20
10 1286	AL .090X36X48	5052	H32		\$/50	IN	16	1
5440-4430	Insert Tapped				Ea		4	
5860-0503	Pad, Tapping				Ea		4	

WORK STATION	- OPERATIONS -			UNIT	CODE	SET-UP	PIECE RATE
M25 A	Shear to size	02-82-05	36	.328	Ea S		
M01 B	Slot	02-83-06	16	.550	Ea S		
M31 C	Perf. & Shear - 8895, 8896, 8897	02-82-07	21	.150	Ea S		
Tool	8986-5943 NC TAPE 8895						
Tool	8986-5993 NC TAPE 8896						
M02 D	C'Bore "E" holes	02-83-04	10	2.0	Ea S		
M76 E	Form - 8895, & 8896	02-82-05	15	.25	Ea S		
M88 F	Clean per ESPM-40	04-82-04	5	3.00	Ea S		
M90 G	Asm. & weld 2995-2890 and square up	02-82-05	50	20.00	Ea S		
M26 H	Blend corner weld, grind, & file inside & outside edge and gage open end	02-83-07	20	15.00	Ea S		
M49 I	Asm. & Swage Insert	02-82-04	10	.10	Ea S		
M02 J	Drill & Tap "C" holes	02-83-04	5	.25	Ea S		
Tool	8986-5944 Drill Fixt.						
M88 K	Ultrasonic Degrease						

APPENDIX C

PARTIAL QUANTITY RECORD

FROM	TO	NO. OF PCS.	INSP. & DATE	CLOSE SHORT

FROM	TO	NO. OF PCS.	INSP. & DATE	CLOSE SHORT

SHOP COPY

OPERATION SHEET

START DATE: _____ Page 2
DUE DATE: _____

PARTIAL QUANTITY RECORD

APPENDIX D

MANUFACTURING DESIGNATIONS

CONCORD

AND

BOLTON

APPENDIX D

Manufacturing Routing Designations for Concord and Bolton

<u>Dept. No.</u>	<u>Distribution Account</u>	<u>Description</u>	<u>Plant</u>	<u>FL.</u>	<u>Bldg.</u>
A10	142-50	Precision Resistance Units, Wind Adjust, Fine Adjust & Dip	C	2	4
A20	141-50	Urethane Foaming Precision Time Base Assembly	B	2	2
A20	247-50	Assembly Precision Time Base	C	1	4
A21	292-52	Assembly, Rubidium Standard, Contracts	B	3	2
A25	145-50	Etched Circuits Assemble Wave or Dip Solder & Clean (Non-Sequential)	C	2	4
A26	145-50	Chemical Clean	C	2	4
A27	145-50	Seq. PC board assembly	C	2	4
A28	145-50	Solder PC board assembly	C	2	4
A29	145-50	Second operation PC board	C	2	4
A30	241-50	Final Asm. E & M Prod.	C	1	4
A40	247-50	Final Asm. E. I. D. Prod.	C	1	4
A74	247-50	874-900's assembly	C	1	4
A76	241-50	Microphone Assembly	C	2	2
B01	142-50	Cables, Cutting & Servicing Leads	C	2	4
B02	142-50	Bobbin Winding	C	2	4
B03	142-50	Precision Winding	C	2	4
B04	142-50	Winding	C	2	4
B05	142-50	Hand Wind	C	2	4
B06	142-50	Formed Resistors	C	2	4

APPENDIX D

Manufacturing Routing Designations for Concord and Bolton

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<u>Dept. No.</u>	<u>Distribution Account</u>	<u>Description</u>	<u>Plant</u>	<u>FL.</u>	<u>Bldg.</u>
B07	142-50	Abrade to Tolerance	C	2	4
B08	142-50	Abrade 1 and 10 ohm Decades to Tolerance	C	2	4
B09	142-50	Stress Relieve	C	2	4
B10	142-50	Bobbin adjust to tolerance	C	2	4
B70	142-50	Drill, Spot Weld, Kick Press Hydraulic Press Assembly (Bead Eyelet Machine)	C	2	4
B71	142-50	Conformal Coating of Precision Resistors	C	2	4
B72	142-50	Routing of loose parts from P50	C	2	4
B73	142-50	Component Assembly, misc. work (U74's and 510 switches)	C	2	4
B75	142-50	Decade Assembly	C	2	4
B76	142-50	Decade Final Test	C	2	4
B77	142-50	Cutting, Score, Service Teflon, Grind and finish 45° point.	C	2	4
B78	142-50	Form Solder Connectors, Color Code and Solder Cables	C	2	4
C10	142-50	Mica Stacking	C	2	1
C11	142-50	Polystyrene Winding & Checking	C	2	1
C12	142-50	Fixed Capacitor Assembly	C	2	1
C13	142-50	Wind and age polystyrene capacitors	C	2	4
C14	142-50	Calibration of polystyrene capacitors	C	2	4
C75	247-50	Instrument Assembly (Capacitor)	C	1	4
DOA		Done on assembly			
D09	145-50	Anti-static protection required	C	2	4
D10	145-50	Kit Preparation	C	2	4
D20	145-50	Kit Inspection (Audit)	C	2	4

APPENDIX D

Manufacturing Routing Designations for Concord and Bolton

-3

<u>Dept. No.</u>	<u>Distribution Account</u>	<u>Description</u>	<u>Plant</u>	<u>Fl.</u>	<u>Bldg.</u>
EMB		Concord Material stored at Bolton to be issued to EMD	C&B	2	2
EMC		Concord material stored at Concord to be issued to EMD	C&B	1	2
E12	236-50	(Mechanical) Engraving, Filling of Engraving	B	1	1
E13	236-50	(Mechanical) Silk Screening	B	1	2
E14	236-50	(Mechanical) Hot Stamping, Markem & Misc. Stamping	B	1	1
E67	236-50	(Mechanical) Silver Solder, Resistance Solder, Induction Solder & Torch Solder	B	1	2
F05	145-50	Chemically Clean P.C. Board	C	2	4
F10	145-50	Install Amp Sockets to P.C. Board	C	2	4
F11	145-50	Install Berg Sockets to P.C. Board	C	2	4
F15	145-50	Install Berg Posts to P.C. Board	C	2	4
F20	145-50	Install Eyelets and Hardware using Pneumatic Press	C	2	4
F25	145-50	Install Eyelets using Kick Press	C	2	4
F30	145-50	Install Hardware by Hand	C	2	4
F35	145-50	Hot Stamp Cams	C	2	4
F40	145-50	Mask P.C. Board	C	2	4
F45	145-50	Prestage P.C. Board	C	2	4
F50	145-50	Component Preparation	C	2	4
F51	145-50	Material Prep.	C	2	4
F55	145-50	Inspect and Audit Material Preparation	C	2	4
G15	142-50	Potentiometer Winding, Clamp Assembly & Perforating	C	2	4
G75	142-50	Bond, clean & buff. Potentiometer Assembly TOM-30 for drilling and Counter Sinking Additional Holes in Potentiometer Bases	C	2	4

APPENDIX D

Manufacturing Routing Designations For Concord and Bolton

-4

<u>Dept. No.</u>	<u>Distribution Account</u>	<u>Description</u>	<u>Plant</u>	<u>Fl.</u>	<u>Bldg.</u>
H20	336-55	Inspection (Mechanical Components) Small Parts Assembly	C	2	4
H30	159-55	Inspection (Mechanical) of Incoming Materials	C	1	2
H30	259-55	Inspection (Mechanical) of Incoming Materials	B	1	1
H60	255-55	In-process Inspection Finishing	B	1	2
H70	255-55	Inspection of Machine Shop Work, Tools, Inspection with Optical Comparator	B	1	1
H82	255-55	Quality Assurance Audit Station	B	1	2
J02	159-55	Burn-in at Incoming Inspection	C	1	2
J05	159-55	Meter Inspection	C	1	2
J10	255-55	Electro-mechanical Microelectronics Final Inspection	B	3	2
J15	155-55	Inspection Resis, card	C	2	4
J16	336-55	Inspection fo Etch Board Assemblies	C	2	4
J17	336-55	Testing of P.C. Assemblies	C	2	2
J20	336-55	Inspection (Electrical) of Small Parts Assembly, Cables & Switches	C	2	4
J21	336-55	Inspection (Electrical) Potentiometer	C	2	4
J26	155-55	Inspection of Mica & Polystyrene Condensers in Process (Dept. C)	C	2	4
J27	336-55	Preinspection	C	2	4
J29	336-55	Final Inspection	C	2	4
J30	159-55	Inspection (Electrical) of Incoming Material	C	1	2
J30	259-55	Inspection (Electrical) of Incoming Material	B	2	2

APPENDIX D

Manufacturing Routing Designations for Concord and Bolton

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<u>Dept. No.</u>	<u>Distribution Account</u>	<u>Description</u>	<u>Plant</u>	<u>Fl.</u>	<u>Bldg.</u>
J31	159-55	Incoming Peripheral Inspection	C	1	2
J40	155-55	Inspection Variac	C	1	1
J50	155-55	Inspection transformer	C	2	4
J80	155-55	Final Calibration Inspection	C	1	4
J81	155-55	Final Instrument Inspection	C	1	4
J90	156-55	Standards and Calibration	C	2	4
K05	145-50	Sequential P.C. Board Assy. #1	C	2	4
K10	145-50	Sequential P.C. Board Assy. #2	C	2	4
K15	145-50	Sequential P.C. Board Assy. #3	C	2	4
K20	145-50	Sequential P.C. Board Assy. #4	C	2	4
K25	145-50	Sequential P.C. Board Assy. #5	C	2	4
K30	145-50	Sequential P.C. Board Assy. #6	C	2	4
K35	145-50	Assemble P.C. Board Complete using Preformed Components	C	2	4
K40	145-50	Hand Form Components and Assemble P. C. Board Complete	C	2	4
K45	145-50	Vacuum Pack P.C. Board	C	2	4
K50	145-50	Trim Vacuum Pack Material and Remove Tooling if Required	C	2	4
K55	145-50	Preinspection	C	2	4
K75	248-50	Finished Inventory assembly	C	1	4
L02	248-55	Burn-in Lab E ID Prod.	C	1	4
L03	244-55	Burn-in at Lab E & M Prod.	C	1	4
L05	244-50	Lab check of Microphones Pickup & Misc. Purchased Items	C	2	2
L09	248-50	Testing & Calibrating 900's and 874's	C	1	4
L21	292-52	Test Rubidium Standard, Contracts	B	3	2

APPENDIX D

Manufacturing Routing Designations for Concord and Bolton

-6

<u>Dept. No.</u>	<u>Distribution Account</u>	<u>Description</u>	<u>Plant</u>	<u>F1.</u>	<u>Bldg.</u>
L30	244-50	Calibration, E & M Prod.	C	1	4
L31	244-50	Lab calibration of boards and instruments that require an air-condition facility	C	2	2
L40	248-50	Calibration E.I.D. Prod.	C	1	4
L41	248-50	Lab Calibration of EID Boards and Instruments that require an air-condition facility	C	2	2
L60	142-50	Cabinet Assembly	C	2	4
MMB		Material to be routed to Bolton Storage - Concord storage area (Concord material handing area in Bolton plant)	C&B	1	2
M01	235-50	(Flatwork) Saw, Round Corners, & Finish edges, Chamfer, Delta Cut Off, Pin Saw Apart Concept, Tap & C'Sink Saw to Length & Chamfer Saw to Length & Form (1531 Rim)	B	1	2
M02	234-50	(Turning) Drill, Flycut, C'Sink C'Bore Spot Face, Tap, Ream & Burr	B	1	2
M25	235-50	(Flatwork) Shear, Shear apart, Shear to size & mill slots (Wilson Cabinets)	B	1	2
M26	235-50	(Flatwork) Grain, Bevel Edges, Break Corners, And Wheel Grind	B	1	2
M30	235-50	(Flatwork) Punch Press, Tap & C'Sink, Radius Corners	B	1	2
M31	235-50	(Flatwork) N/C Control Turret Press, perforate and shear apart tap and C'sink	B	1	2
M32	235-50	(Flatwork) Wiedeman Hand Turret Press, Tap, C'sink, Perforate, Perforate and Tap (flat single piece)	B	1	2
M36	234-50	(Turning) J & L Borematic, Tracer Attachment	B	1	2
M37	234-50	(Turning) Lathe Work (Except Turret)	B	1	2

APPENDIX D

Manufacturing Routing Designations for Concord and Bolton

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<u>Dept. No.</u>	<u>Distribution Account</u>	<u>Description</u>	<u>Plant</u>	<u>F1.</u>	<u>Bldg.</u>
M40	234-50	(Turning) Mill	B	1	2
M41	234-50	(Turning) Mill Condenser, Rotors & Stators	B	1	1
M42	234-50	(Turning) Moog (Tape Drill, Bore, Ream & Mill)	B	1	2
M43	234-50	(Turning) Centerless Grind, Hone	B	1	2
M49	235-50	(Flatwork) Knob Work (Kingsbury) Misc. Machining, Kick Press Assembly, V-Die Form, Perforate, Notch & Slot. Hydraulic Press Assembly, Component Assembly & Misc. Drill, Tap & Assemble Inserts Tap (A), Open (F) & (C) Holes, Asm. Inserts	B	1	2
M70	235-50	Spot welding Components Assembly Automatic Pin Machine,		2	2
M76	235-50	(Flatwork) Form & C'sink (Hydraulic Press Brake)	B	1	2
M80	234-50	(Turning) Number 2 Turret Lathe Number 3 Turret Lathe Number 4 Turret Lathe Note OPTIMUM Machine on Operation Sheet	B	1	2
M81	234-50	(Turning) Automatic Screw Machine 1 1/6 Max. Dia.	B	1	2
M82	234-50	(Turning) Chuckers	B	1	2
M83	234-50	(Turning) B & S Automatics 3/4 - 1 5/8	B	1	2
M85	234-50	(Turning) Number 0 Screw Machine 5/8 Max. Dia.	B	1	2
M88	237-50	(Chemical) Ultrasonic Degrease Clean per ESPM	B	1	2
M89	234-50	(Turning) Degrease, Clean per ESPM-40 Vibratory, Tumble Lap, Heat Treat, Barrel Deburr (Bar Stock Area)	B	1	2
M90	235-50	(Flatwork) Torch Weld, ARC Weld Rout Weld, Solder Aluminum	B	1	2

APPENDIX D

Manufacturing Routing Designations for Concord and Bolton

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<u>Dept. No.</u>	<u>Distribution Account</u>	<u>Description</u>	<u>Plant</u>	<u>Fl.</u>	<u>Bldg.</u>
M91	235-50	(Flatwork) Stud Welding	B	1	2
M92	235-50	(Flatwork) Bag & Mark Per ESPM-229	B	1	2
M93	235-50	Plastic Moulder Newbury (4 oz.-75 ton) 8985-0150 Van Dorn (2.5 oz.-20 ton) 8985-0110 Bench Press (Hand) 8985-0758 Bench Press (Air) 8985-0759	B	2	2
NSL		No Stocking location			
N05	236-50	(Mechanical) Buff, Centerless Grain Wire Brush, Scratch Brush	B	1	2
N10	237-50	(Chemical) Finish Chemical Cleaning Designated on drawings for final appearance of parts. Ultrasonic clean. Clean per specs ESFC-9 Potash & acid dip	B	1	1
N20	237-50	(Chemical) Finish-Plated per Eng. Specs - Also ESFC-10 - Bright Dip -14 - Cleaning ASM. after Soldering -15 - Clean Brass after Buffing -17 - Clean Parts before Soldering -19 - Clean Silver Solder ASM.	B	1	1
N25	237-50	(Chemical) Finish - includes masking & spraying of all types of Paint Finishes and Ultrasonic Degreasing	B	1	1
O10		Purchase Work Station (Subsequent to P50)	C	1	2
O11		Material For Outside Work	C	1	2
O11		Material for Outside Work	B	1	2
P20		Sub-assembly stock	C	1	2
P50		Parts Stock	C	1	2
P55		Raw Stock	C	1	2

APPENDIX D

Manufacturing Routing Designations for Concord and Bolton

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<u>Dept. No.</u>	<u>Distribution Account</u>	<u>Description</u>	<u>Plant</u>	<u>F1.</u>	<u>Bldg.</u>
P55		Raw Stock	B	1	2
P56		Parts (Listed on Operation Sheets)	C		
P56		Parts (Listed on Operation Sheets)	B	2	1
P60		Wire Stock	C	1	2
P72		Alpha Stocking Location	C	2	3
P90		Wrapped Item Physically Located Outside the Wrapping Room	C	1	3
P99		Detention Area for Non-Conforming Material	C	1	2
Q05	145-50	Prebake P.C. Board	C	2	4
Q10	145-50	Wave Solder P.C. Board	C	2	4
Q15	145-50	Hand Solder P.C. Board	C	2	4
Q20	145-50	Solder P.C. Board Using Peanut Oil	C	2	4
Q25	145-50	Clean P.C. Board Using Vapor Degreaser & Chemical Solvent	C	2	4
Q30	145-50	Clean P.C. Board using Detergent and Deionized Water	C	2	4
Q35	145-50	Solder Touch up, P.C. Board Rework and Final Clean	C	2	4
REJ		Reject Parts Storage Area	C	1	2
R05	145-50	Install Lead Sets	C	2	4
R10	145-50	Install Stiffener	C	2	4
R15	145-50	Install Components	C	2	4
R20	145-50	Wire Wrap P.C. Board	C	2	4
R25	145-50	Stamp P.C. Board Number	C	2	4
R30	145-50	Install Cams or Other Parts	C	2	4
R35	145-50	Heat Stabilization Cycle	C	2	4
RW1		Rework Holding Area	C	2	2
RW2		Rework Stocking Location	B	2	1

APPENDIX D

Manufacturing Routing Designations for Concord and Bolton

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<u>Dept. No.</u>	<u>Distribution Account</u>	<u>Description</u>	<u>Plant</u>	<u>F1.</u>	<u>Bldg.</u>
R40	145-50	Second Operation	C	2	4
500		Sequential P.C. Board Operations	C	2	4
S02	335-55	Run-in at Systems Center	C	2	1
S03	335-55	Burn-in of TSD Product	C	1	3
S11	169-55	Shipping	C	1	3
S20	339-50	Module Assembly	C	2	1
S21	335-50	1790 Test	C	2	1
S22	335-50	1792-A Test	C	2	1
S23	335-50	Test Beds	C	2	1
S24	335-50	Peripheral Test	C	2	1
S25-A	335-50	Module Test	C	2	1
S25-B	335-50	Module Test	C	2	1
S26	359-50	CANDI	C	2	1
S26-A	359-50	CANDI Test	C	2	1
S27	358-50	High Frequency System	C	2	1
S28	335-50	2210-C Test	C	2	1
S35	146-50	Systems Test	C	2	1
S75	338-50	Systems Assembly	C	2	1
T01	140-62	Tool Dept. (Electrical)	C	2	1
T02	240-62	Tool Dept. (Mechanical) (X-Shop)	C	3	2
T02	240-62	Tool Department	B	2	2
V15	147-50	Variac Winding	C	1	1
V26	147-50	Furane & Coin	C	1	1
V35	147-50	Grind	C	1	1
V45	147-50	Misc. - Spot grind for plating, Polish Grind Brush Track, Stack Coil, and etc.	C	1	1
V55	147-50	Varnish	C	1	1

APPENDIX D

Manufacturing Routing Designations for Concord and Bolton

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<u>Dept. No.</u>	<u>Distribution Account</u>	<u>Description</u>	<u>Plant</u>	<u>Fl.</u>	<u>Bldg.</u>
V70	147-50	Brush Assembly, Radiator Assembly, Terminal Plate Assembly & Winding Form Assembly, Shaft Assembly, Terminal Assembly & Artos	C	1	1
V75	147-50	Variac Assembly	C	1	1
W15		Sub contract to Bolton	C	2	4
W15	242-50	Coil Winding, Wave Winding	B	2	2
W35		Sub contract to Bolton	C	2	4
W35	242-50	Coil Assembly, Transformer Assembly	B	2	2
W45		Sub contract to Bolton		2	4
W45	242-50	Toroidal Winding (Machine) Toroidal Winding (Hand)	B	2	2
X01		X-Shop	C	2	3
YVL		Yield value labor	C		
Y10	139-55	Partial Parts Loose Sales Stock	C	1	2
Y11	169-50	Sales Stock, Wrapping	C	1	3
Y15	312-55	Assembly of Instruction Books	C	2	3
Y20	312-55	Proof reading instruction Material	C	2	3
Z05	142-50	Conformal Coating of Etch Boards	C	2	4
Z99		Tub File Station	C	2	2
111	142-50	In-process inspection and marking of Precision Resistors	C	2	4
112	147-50	Variac Inspection	C	1	1
113	242-50	Trans. Insp.	B	2	2
281	292-50	Glass Shop	B	3	2
284	284-52	Micro-electronics	B	3	2

APPENDIX E

TOOL LIST

Preceding Page BLANK - FILMED

APPENDIX E

TRACKING SERVO BRIDGE DETECTOR

TOOL LIST

<u>Tool No.</u>	<u>Qty.</u>	<u>Description</u>	<u>W/U</u>	<u>W/S</u>
8986-8174	1	NC Tape	1891	M42
8986-8175	1	Silk Screen	1891	E13
8986-8176	1	NC Tape	1893	M31
8986-8177	1	Drill Fixture	1860	M02
8986-8178	1	NC Tape	1843	M31
8986-8179	1	Drill Fixture	1865	M02
8986-8180	1	Silk Screen	1865	E13
8986-8181	1	Form'g Fixture	2856	B73
8986-9414	1	NC Tape	1890	M31
8986-5946	1	Form'g Fixture	2858	B73
8986-8182	1	Form'g Fixture	2859	B73
8986-8183	1	Form'g Fixture	2864	B73
8986-8184	1	Form'g Fixture	2865	B73
8986-8185	1	Form'g Fixture	2866	B73
			2868	B73
8986-5955	1	Form'g Fixture	2869	B73
8986-8186	1	Form'g Fixture	2867	B73
			2879	B73
			2893	B73
8986-3187	1	NC Tape	8875	M31
8986-8189	1	NC Tape	8877	M31
8986-8190	1	NC Tape	8878	M31
8986-8191	1	NC Tape	2879	M31
8986-8198	1	Engraving Template	6846	E12

APPENDIX E

Tracking Servo Bridge Detector - Tool List

- 2 -

<u>Tool No.</u>	<u>Qty.</u>	<u>Description</u>	<u>W/U</u>	<u>W/S</u>
8986-5943	1	NC Tape	2890	M31
8986-5993	1	NC Tape	2890	M31
8986-5944	1	Drill Fixture	2890	M02
8986-5949	1	Form'g Fixture	2855	B73
8986-5950	1	Holding Fixture	2857	B73
8986-5955	1	Form'g Fixture	2861	B73
8986-8199	1	Drill Fixture	8880	M02
			8881	M02
8986-8171	1	NC Tape	1888	M31
8986-8172	1	NC Tape	1889	M31
8986-8795	1	Drill Fixture	8885	M02
8986-8200	1	NC Tape	8882	M42
8986-8193	1	NC Tape	1880	M31
8986-8194	1	Silk Screen	1880	E13
8986-8196	1	Drill Fixture	8891	M02
8986-8197	1	Form'g Fixture	8894	M49

W/U = Where Used (Part No.)

W/S = Work Station

APPENDIX F
TEST FIXTURE LIST

APPENDIX F

TRACKING SERVO BRIDGE DETECTOR

TEST FIXTURE LIST

<u>Tool No.</u>	<u>Qty.</u>	<u>Description</u>	<u>W/U</u>	<u>W/S</u>
8986-8163	1	Servo Amplifier	4766	L01
8986-8169	1	±18V Preregulator Supply	4766 4784 4785 4786 4787 4788 4860	L01
8986-8165	1	Generator Isolation Module	4786	L01
		LO Isolation Module	4787	L01
8986-8166	1	Synchronous Detector	4785	L01
		IF Reference Phase Shifter	4784	L01
8986-8167	1	X10 Frequency Multiplier	4781	L01
8986-8168	1	IF Amplifier	4788	L01
8986-8164	1	Power Supply	4765	L01
8986-8170	1	RF Module Power Supply	4781	L01
8986-5991	1	Offset LO Connector	*	L01
8986-5992	1	Low Pass Filter	4781	L01
8986-5995	1	Crystal Filter	*	L01

*Complete Instrument

APPENDIX G

WAGE ADMINISTRATION PLAN

APPENDIX G

WAGE ADMINISTRATION PLAN

<u>Work Station</u>	<u>Code</u>	<u>New Job Code</u>	<u>Skill</u>	<u>Descrip.</u>	<u>Grade</u>	<u>Job Content</u>
M01		02	83	05		Delta cut off. Groove cabinets, hendrick tri-rail power saw speed mill cabinet groove.
M02		02	83	04		Drill, tap, C'sink, etc.
"		02	83	05		C'Bore to tol. ± .005, flycut, ream to tol. ± .001.
"		02	83	06		Drill precision work, complicated casting.
M25		02	82	05		Shear
M26		02	83	04		All sanding machines
"		02	83	05		Grind and blend cabinets
"	S	02	83	04		Flatten
M30		02	82	06		Punch press
M31	S	02	82	07		N.C. Behrens
M32		02	82	05		Wiedemann
M36		02	83	07		J&L Borematic, tracer attachment
M37		02	83	06		Engine Lathe
"		02	83	07		
M40		02	83	05		Nichols Miller-small parts slots, flats,
"		02	83	06		and mill, hand mill & mill Cincinnati -
"		02	83	07		large parts, mult. cuts.
M41		02	83	07		GR condenser milling machine Heald Boromat
M42	S	02	83	08		Moog taped mill
M43		02	83	06		Centerless grind, hone
M49		02	82	04		Kick press
"		02	82	05		
"		02	82	05		Hydraulic press
"		02	83	04		Knob machine
"		02	83	05		Injection mold
"		02	82	04		Wall press inserts
"		02	83	05		Might midget-surface grinder-Pope saw straighten rods & tubes
M50		02	83	06		Straight time 1790 job
M70		02	82	05		Spot weld
"		02	82	04		Pin machine Kick press

APPENDIX G

Wage Administration Plan (cont.)

<u>Work Station</u>	<u>Code</u>	<u>New Job Code</u>			<u>Job Content</u>
		<u>Skill</u>	<u>Descrip.</u>	<u>Grade</u>	
M76 "	02	02	82	05	Form on brake to normal tol.
		02	82	06	Mult. form to close tol.(5 or 6 bends or more)
M80 "		02	83	06	No. 3-4, Turret lathe
		02	83	07	
M81	S	02	83	07	Automatic screw mach. (3) Hardinge
M82		02	83	07	Chucker, Cold room
M83	S	02	83	08	B & S Automatic (2)
M85 "		02	83	05	Hand screw mach. (Run of mill)
		02	83	06	Hand screw mach. (Close tol. ± .001)
M88	S	04	82	05	Deg. (Plating Area) Ultrasonic Deg. (Painting area)
M89 "	S	04	82	05	Degrease, heat treat
	S	02	83	05	Vibratory tumble, lap, barrel deburr
M90 "		02	82	06	Spot weld, airco matic
		02	85	07	Arc weld, rout weld, torch solder, etc.
M91		02	82	05	Studweld
M92	S	03	81	04	Packaging oper.(ESPM 229 - Bag, mark and seal small parts)
N05 "		02	83	04	Hydra Blast, buff, grain, tumble, etc.
		02	83	05	Silicon treat tubes
N10		04	82	05	Potash & acid dip, Ultrasonic clean
N20		04	81	07	Electro plate, clean per ESFC-10, 14, 15, 17, 19
N25		04	84	06	Spray all finishes other than varnish. Spray paint varnish or lacquer.
E12 " "	04	84	06	Rout windows	
	04	83	04	Fill (alone)	
	02	84	06	Engrave with dividing head or feel, make template, etc. Engrave with depth gauge.	
E13		04	83	06	Silk Screen
E14	S	02	83	04	Markem stamp - hot stamp
E67 "		02	85	05	Soft soldering mechanical parts
		02	85	06	Silver solder, close tol. solder mech. part

APPENDIX G

Wage Administration Plan (cont.)

<u>Work Station</u>	<u>Code</u>	<u>New Job Code</u>		<u>Job Content</u>
		<u>Skill</u>	<u>Descrip.</u>	
W15	03	83	05 06	See "guide for grade rating" sheet See "guide for grade rating" sheet
W35	03	81	04 05	See "guide for grade rating" sheet See "guide for grade rating" sheet
W45	03	83	06	Toroidal coil winding

APPENDIX H
CLASSIFICATION OF QUALITY DEFECTS

APPENDIX H

CLASSIFICATION OF QUALITY DEFECTS

I. Workmanship Defects

A. Hand Soldering

Not soldered at all	Rosin joint
Insufficient solder	Excess flux
Solder short	Burnt insulation
Cold joint	

B. Printed Circuit Boards

Solder bridge	Incorrect part (electrical)
Insufficient flow	Missing part (electrical)
Dewetting	Component oriented incorrectly
Burnt board or component	

C. Mechanical Assembly

Loose hardware	Defective dial drive
Incorrectly oriented knob/dial	Loose foreign material
Incorrect part (electrical)	Component oriented incorrectly
Incorrect part (mechanical)	Coax connector improperly assembled
Missing part (electrical)	Binding post oriented wrong
Missing part (mechanical)	Pinched lead

D. Wiring

Lead oriented error	Improper wirewrap
Broken lead	Improper wrapped joint
Miswired	

E. Process

Heat Treatment	Color
Incorrect Process	Improper Finish
Damaged Paint/Finish	Improper Cleaning
Incorrect Marking	Missing Marking

F. Fabrication

Out of tolerance	Material Incorrect
Improper Riveting	Voids in weldments

APPENDIX H

Classification of Quality Defects (cont.)

II. Material Defects

<u>Purchased</u>	<u>GR Manufactured</u>
Analog Meter	Hybrid Microcircuits
Digital Meter	
Switch	Switch
Battery	
Electron Tube	
Connector	Connector
Linear I.C.	
Digital I.C.	
A/D or D/A Converter	A/D or D/A Converter
Transformers	Transformer
Resistors	Resistor
Capacitors	Capacitor
Inductors	Inductor
Transistor	
Microphone	Microphone
Transducer	Transducer
Functional Module	
Diode	
Random Access Memory	
Relays	Cables
Cables	Mechanical Parts
Mechanical Parts	Peripherals
Peripherals	
Molded Plastic Parts	
Motors/Fans	

III. General Defects

- Missing documentation
- Missing accessories
- Shipping damage
- Cannot confirm customer complaint
- Missing modifications
- Faulty maintenance
- Improper handling

APPENDIX I

ACCEPTABLE QUALITY LEVELS FOR COMPONENTS

APPENDIX I

ACCEPTABLE QUALITY LEVELS FOR COMPONENTS

AOQL = 1%

Thermistors
Thyrites
Electron Tubes

AOQL = 2%

Resistors
Fuses
Relays
Indicator Tubes
Rotary Switches

AOQL = 4%

Machine Parts -
Multiple operations
(Turn, mill, drill,
ream)
Reed Switch Magnet
Batteries
Connectors
Power Cords
Pilot Lamps
Toggle Switches
Slide Switches
Crystals

AOQL = 10%

Gears
Brush Carbons
Dials
Finish eg
Punch & Die (laminations)
Machined Spacer
Plug, Socket, Connector
Molded Part
Knob
Hardware-standard Stock
P.C. Boards
Terminal Board
Shafting
Centerless Ground
Chart Paper
Case-leather, Plastic
Deep Drawn Item-eg. Cabinet
Part, Shield Can

Inspect 10 Pieces

Variac Core

Inspect 1 Piece

Casting

Based on

DODGE - ROMIG
Double Sampling
AOQL Plans

AOQL =

Average Outgoing Quality Limit

/dcs